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KARYOTYPES OF SEVENTEEN USA SPIDER SPECIES (ARANEAE, ARANEIDAE, GNAPHOSIDAE, LOXOSCELIDAE, LYCOSIDAE, OXYOPIDAE, PHILODROMIDAE, SALTICIDAE AND THERIDIIDAE)

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ABSTRACT

Karyotypes are reported for 17 species from eight families of spiders from Texas and Missouri. Chromosomal counts (2N) are as follows: Araneidae—*Eustala emertoni*, 24; Gnaphosidae—*Cesonia sincera*, 22 and 24; *Nodocion floridanus*, 24; Loxoscelidae—*Loxosceles reclusa*, 18 and 20; Lycosidae—*Lycosa rabida*, 28 and 30; Oxyopidae—*Oxyopes scalaris*, 21; Philodromidae—*Tibellus duttoni*, 29; Salticidae—*Maevia inclemens*, 27 and 28; *Marpissa pikei*, 28; *Metaphidippus galathea*, 27 and 28; *Peckhamia americana*, 22 and 24; *Phidippus audax*, 28 and 30; *Phidippus texanus*, 28 and 30; *Platycryptus undatus*, 28 and 30; *Salticus austinesis*, 28 and 30; *Tutelina elegans*, 27 and 28; and Theridiidae—*Steatoda triangulosa*, 22 and 24.

INTRODUCTION

A thorough search of the literature indicates chromosomal data (counts) are available for approximately 300 of the more than 30,000 spider species (Gowan 1985; Datta and Chatterjee 1988). Most of these are reported from the Old World and many are identified only at the generic level. This study adds karyotypic data for 14 additional identified species and three that have been previously reported.

MATERIALS AND METHODS

Specimens for the present study were collected from north-central Texas with the exception of *Oxyopes scalaris* Hentz and *Tutelina elegans* (Hentz) which were from eastern Missouri.

The meiotic studies were accomplished by examining the ovaries and testes of penultimate and mature spiders. The meiotic procedure used was an air-dry method developed by Cokendolpher and Brown (1985). The only modification was the stain. The commercially available Diff-Quick Solution II was used to stain the chromosomes. This staining solution consisted of 1.25 g/l thiazine dye mixture, 100% PDC (0.625 g/l azure A and 0.625 g/l methylene blue) and buffer.

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Five-day-old eggs (embryos) were used for the mitotic studies. The procedure followed was a modification of Matsumoto's (1977) method. Substitutions included the use of methanol instead of ethyl alcohol in the fixative, the use of four eggs instead of one, and a pH of 7.0 for the saline solution instead of 7.2. All mitotic preparations were flame dried and stained with Giemsa. The stain was prepared by mixing 2 to 3 ml of Giemsa with 50 ml phosphate buffer (0.469 g sodium dihydrogen phosphate, 0.937 g sodium monohydrogen phosphate/l water).

Chromosome numbers were determined by counting spreads for each species. The most frequent chromosome counts were regarded as the valid number. In mitotic studies, species where two different consistent counts were noted, they were assumed to be due to the sex determining mechanism.

Specimens sacrificed for meiotic studies and females that produced the eggs for the mitotic studies are deposited in the Invertebrate Collection at Midwestern State University.

RESULTS AND DISCUSSION

Eggs are excellent sources of somatic cells that provide good mitotic spreads. At present, spider karyotyping techniques for somatic cells are not sufficient to observe the sex-determining mechanisms. We agree with Matsumoto's (1977) deductions that meiotic preparations are necessary for determination of the sexing mechanisms.

Tables 1 and 2 list the results of meiotic and mitotic works, respectively. The tables indicate the species studied, diploid (2n) numbers, sex-determining mechanisms in meiotic studies, and geographic location. References are made to previous studies where researchers examined the same or closely related species. Some counts in this study do not agree with the previously reported results (see Table 1). This may be due to counting error, improper identification or even geographic variation. Representative photographs of all species examined are shown in Figs. 1-25 with the exception of *Lycosa rabida* Walckenaer and *Peckhamia americana* (Peckham and Peckham) which were unavailable.

Datta and Chatterjee (1988) report that 55 species of Araneidae have been karyotyped. The 2n number ranges from 14 to 46 with 24 being the most common. Our study is the first to report a karyotype for *Eustala emertoni* (Banks) (Fig. 1). It is 2n=24, as are 81% of the other Araneidae. Since this is a mitotic study no sex-determining mechanism is confirmed.

According to the literature 13 different species of Gnaphosidae have been reported (Painter 1914; Hackman 1948; Suzuki 1952; Mittal 1961). With the exception of *Scotophaeus blackwallii* (Thorell), which Mittal (1961) reported as having 11 autosomal pairs and an XXO-XXXX sex-determining mechanism, all other Gnaphosidae cytogenetically known have 10 autosomal pairs and an XXO-XXXX sex-determining mechanism (Painter 1914; Hackman 1948; Suzuki 1952; Mittal 1961). *Cesonia sincera* Gertsch and Mulaik (Figs. 2-3) and *Nodocion floridanus* (Banks) (Fig. 4) mitotic studies show this same consistency. These two karyotypes are the first reported for their respective genera.

Our figures show *Loxosceles reclusa* Gertsch and Mulaik (Loxoscelidae) males as 2n=22 and females as 2n=24 and a sex determining mechanism of XXO-

Table 1.—Meiotic Studies. Species, diploid number, number of individuals examined ( ), sex-determining mechanism, geographic location and selected supportive references.

Species	Diploid number		Sex determining mechanism		Geographic location	References
	Male	Female	Male	Female		
ARANEIDAE						
Eustala sp.	24	—	XXO	—	Asia	Mittal 1961
LOXOSCELIDAE						
Loxosceles reclusa Gertsch & Mulaik	18(9)	20(2)	XXO-XXXX		N.A. (TX)	Current study
L. rufipes (Lucas) [prob. *L. laeta*-see text]	20		XXO-XXXX		S.A.	Diaz & Saez 1966
LYCOSIDAE						
Lycosa rabida Walck.	28(1)	30(1)	XXO-XXXX		N.A. (TX)	Current study
L. rabida	28	30	XXO-XXXX		N.A. (MS)	Wise 1983
OXYOPIDAE						
Oxyopes seratus (L. Koch)	21	22	XO-XX		Asia (Japan)	Suzuki 1952
PHILODROMIDAE						
Tibellus oblongus (Walck.)	24	26	XXO-XXXX		Asia	Sokolov 1962
T. tenellus (L. Koch)	28	30	XXO-XXXX		Asia (Japan)	Suzuki 1952
SALTICIDAE						
Maevia inclemen [reported as *M. vittata* Hentz]	28	30	XXO-XXXX		N.A.	Painter 1914
Peckhamia americana (Peck. & Peck.)	22(3)	24(3)	XXO-XXXX		N.A. (TX)	Current study
Phidippus audax (Hentz)	28(1)	30(1)	XXO-XXXX		N.A. (TX)	Current study
Phidippus audax (Hentz)	22	24	XXO-XXXX		N.A. (TX)	Pinter & Walters 1971
Salticus austinensis Gertsch	28(7)	30(3)	XXO-XXXX		N.A. (TX)	Current study
S. cingulatus (Panzer)	28	30	XXO-XXXX		Asia	Sokolov 1960
THERIDIIDAE						
Steatoda triangulosa (Walck.)	22(3)	24(5)	XXO-XXXX		N.A. (TX)	Current study
S. bipunctata (L.)	22	24	XXO-XXXX		Europe	Hackman 1948

XXXX (Figs. 5-6). Of the two *Loxosceles* species previously reported, the sex-determining mechanism is identical but they have a different number of autosomal pairs. *Loxosceles rufescens* (Dufour) and *L. rufipes* (Lucus) are reported by Beçak and Beçak (1960) and Diaz and Saez (1966) respectively as 2n=20. These workers examined only males. Based upon Gertsch's (1967) revision

Table 2.—Mitotic Studies. Species, diploid number, number spreads examined ( ) and geographical location.

Species	Diploid numbers	Geographic location
ARANEIDAE		
Eustala emertoni (Banks)	24(4)	N.A.,(TX)
GNAPHOSIDAE		
Cesonia sincera Gertsch & Mulaik	22(1) 24(1)	N.A.,(TX)
Nodocion floridanus (Banks)	24(4)	N.A.,(TX)
OXYOPIDAE		
Oxyopes scalaris Hentz	21(4)	N.A.,(MO)
PHILODROMIDAE		
Tibellus duttoni (Hentz)	29(3)	N.A.,(TX)
SALTICIDAE		
Maevia inclemens (Walckenaer)	27(4) 28(4)	N.A.,(TX)
Marpissa pikei (Peckham & Peckham)	28(8)	N.A.,(TX)
Metaphidippus galathea (Walckenaer)	27(8) 28(3)	N.A.,(TX)
Phidippus audax (Hentz)	28(39) 30(12)	N.A.,(TX)
Phidippus texanus Banks	28(3) 30(8)	N.A.,(TX)
Platycryptus undatus (De Geer)	28(3) 30(8)	N.A.,(TX)
Salticus austinensis Gertsch	28(1) 30(1)	N.A. (TX)
Tutelina elegans (Hentz)	27(9) 28(8)	N.A. (MO)
THERIDIIDAE		
Steatoda triangulosa (Walckenaer)	22(19) 24(1)	N.A.,(TX)

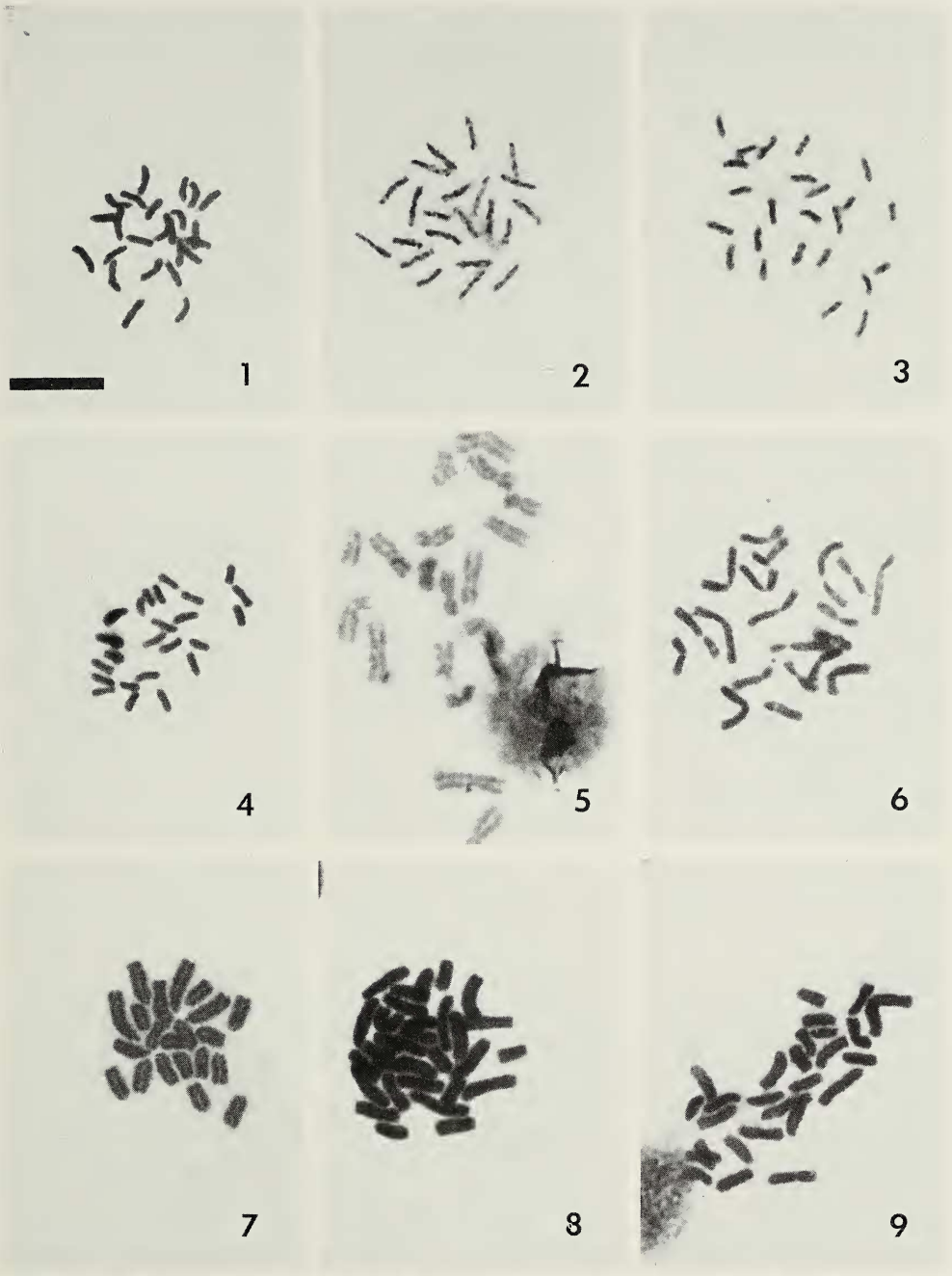
these reported species, *L. rufescens* and *L. rufipes* are probably misidentified and should be *L. gaucho* and *L. laeta* respectively.

Gowan's (1985) survey of the literature revealed karyotypes of approximately 62 different, identified, species of Lycosidae. Diploid counts range from 22 to 30 with 13 autosomal pairs and an XXO-XXXX sex-determining mechanism being the most common. Our findings for *Lycosa rabida* Walckenaer agree with those of Wise (1983) and match the modal number for the family.

In the Oxyopidae three genera and approximately eight, identified, species have been karyotyped (Painter 1914; Hackman 1948; Bole-Gowda 1950; Suzuki 1950, 1952; Sharma and Tandon 1957; Mittal 1961). All but *Oxyopes salticus* L. Koch (Painter 1914) and *Peucetia viridana* Stoliczka (Bole-Gowda 1950) have 10 autosomal pairs and an XO-XX sex-determining mechanism. This study revealed that the mitotic spreads of *Oxyopes scalaris* (Fig. 7) had a 2n count of 21.

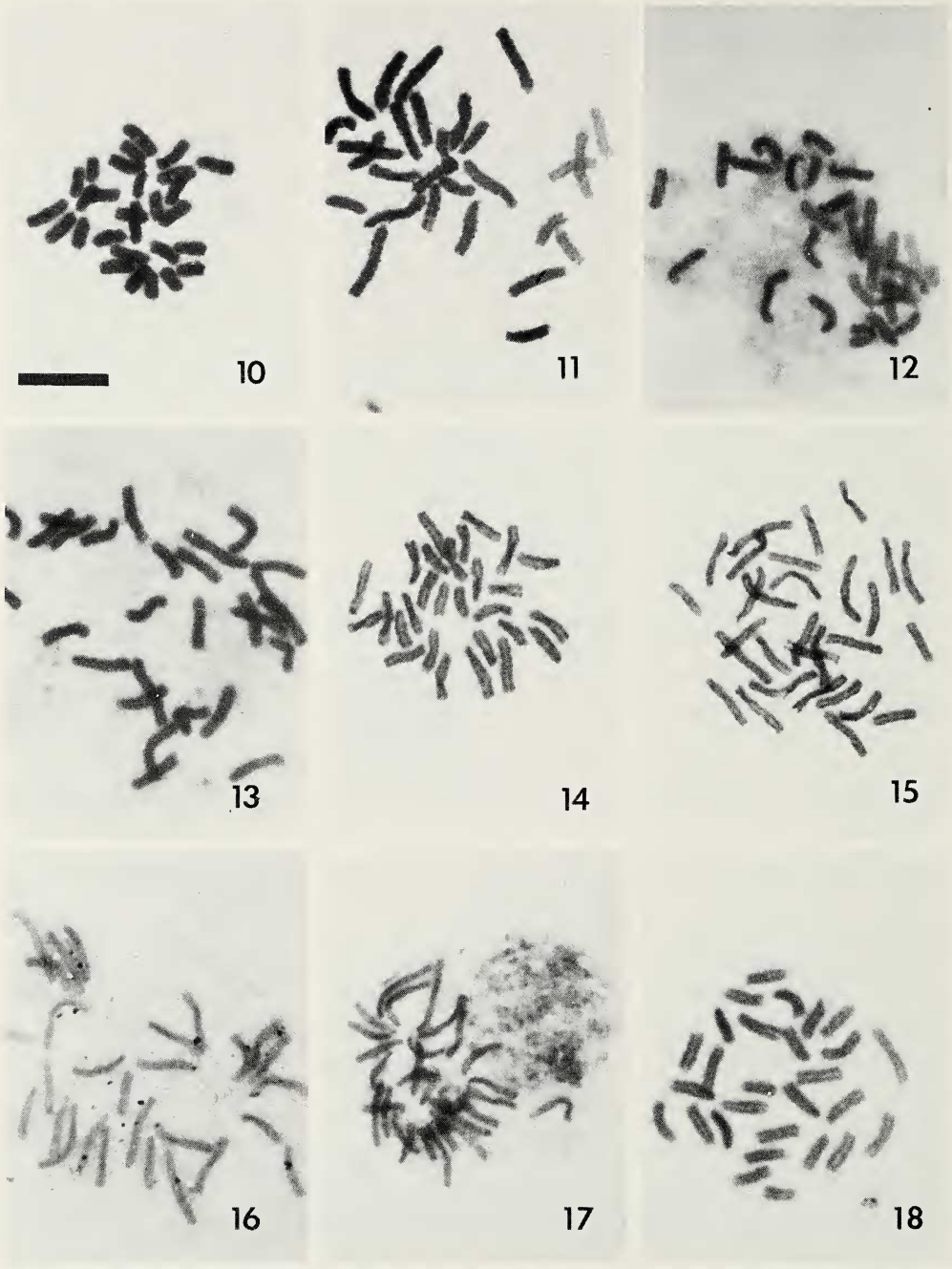
Thirteen autosomal pairs and an XXO-XXXX sex-determining mechanism is the most common number for members of the Philodromidae (Hackman 1948; Sokolov 1960; Suzuki 1952). The 2n count obtained from mitotic spreads for *Tibellus duttoni* (Hentz) (Fig. 8) is 29. Variation from this count has been reported for *T. oblongus* (Walckenaer) (Hackman 1948) and *T. tenellus* (L. Koch) (Suzuki 1952) as indicated in Table 1. Further studies are needed for conclusive counts within the genus and of this species.

Karyotypes from approximately 50 species of Salticidae have been previously reported by Gowan (1985). *Maevia inclemens* (Walckenaer) (Figs. 9-10), previously known as *Maevia vittata* Hentz, was karyotyped by Painter (1914). He worked with two morphologically different males but reported no variation in the chromosome numbers. Only one of the diploid numbers obtained in this study agreed with Painter.



Figures 1-9.—Chromosome spreads of: 1, *Eustala emertoni* 2n=24; 2,3, *Cesonia sincera*; 2, 2n=22; 3, 2n=24; 4, *Nodocion floridanus* 2n=24; 5,6, *Loxosceles reclusa*; 5, male 2n=18; 6, female 2n=20; 7, *Oxyopes scalaris* 2n=21; 8, *Tibellus duttoni* 2n=29; 9, *Maevia inclemens* 2n=27. Scale bar=10 μm.

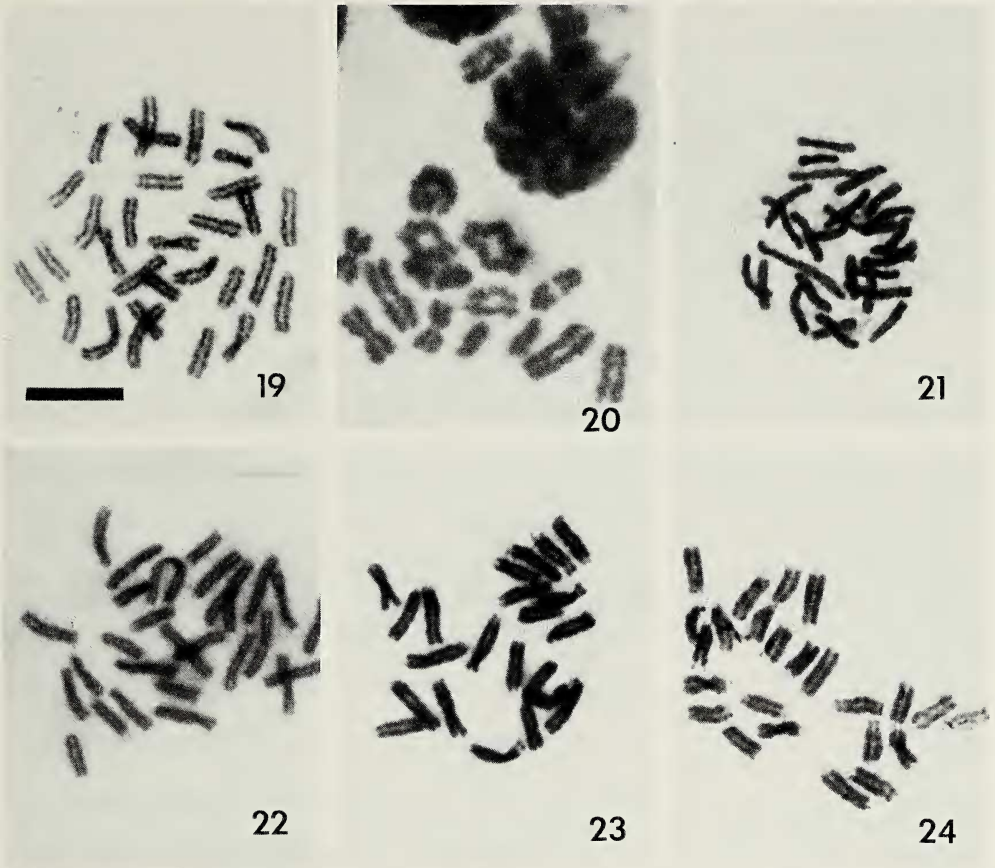
Karyotypes of *Marpissa pikei* (Peckham and Peckham) (Fig. 11), *Metaphidippus galathea* (Walckenaer) (Figs. 12-13), *Peckhamia americana* (Peckham and Peckham), *Platycryptus undatus* (De Geer) (Figs. 18-19) and *Tutelina elegans* (Hentz) (Figs. 21-22) are reported for the first time. As these are



Figures 10-18.—Chromosome spreads of: 10, *Maevia inclemens* 2n=28; 11, *Marpissa pikei* 2n=28; 12,13, *Metaphidippus galathea*; 12, 2n=27; 13, 2n=28; 14,15, *Phidippus audax*; 14, males 2n=28; 15, females 2n=30; 16,17, *Phidippus texanus*; 16, 2n=28; 17, 2n=30; 18, *Platycryptus undatus* 2n=28. Scale bar=10 μm.

also the first reported for each genus no data on related forms are available for comparison.

Phidippus audax (Hentz) (Figs. 14-15) counts do not agree with those reported by Pinter and Walters (1971). However, the meiotic and mitotic counts in this



Figures 19-24.—Chromosome spreads of: 19, *Platycryptus undatus* 2n=30; 20, *Salticus austinesis* male n=13 and XXO (the X's are indicated with arrows); 21,22, *Tutelina elegans*; 21, 2n=27; 22, 2n=28; 23,24, *Steatoda triangulosa*; 23, males 2n=22; 24, females 2n=24. Scale bar=10 μm.

research were consistent and supportive for 2n counts of 28 and 30 with a sexing mechanism of XXO-XXXX. These diploid numbers were also found by Maddison (Gowan 1985). *Phidippus texanus* Banks (Figs. 16-17) diploid counts from mitotic studies were consistent with those of *P. audax*. *Salticus austinesis* Gertsch (Fig. 20) diploid counts agree with *Salticus cingulatus* (Panzer) (Sokolov 1960) and *Salticus scenicus* (Clerck) (Hackman 1948). *Phidippus texanus* Banks and *Salticus austinesis* Gertsch are reported for the first time.

Eight genera and 13 species of Theridiidae have been karyotyped. With the exception of *Chrysso venusta* (Yaginuma) which has 11 autosomal pairs and an XXO-XXXX sex-determining mechanism (Kageyama and Seto 1979) all reported theridiids have 10 autosomal pairs and a XXO-XXXX sex-determining mechanism. *Steatoda triangulosa* (Walckenaer) (Figs. 23-24) typifies this pattern.

Many additional species must be karyotyped, and correct identification determined before assessing any inter- and intra-specific chromosomal variation. With the development of consistent banding techniques in spiders, it may be possible to determine homologies and devise a standard numbering system at least within some genera. It could then be possible to determine the diploid number for each sex from somatic cells such as eggs (embryos).

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